IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

Klaus ABT et al.

Corres. to PCT/EP2005/002412

For: CONTAINER AND TOOL FOR FIXING A CONNECTION

VERIFICATION OF TRANSLATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Charles Edward SITCH,
Acting Managing Director of RWS Group Ltd UK Translation Division, of Europa House, Marsham Way, Gerrards Cross, Buckinghamshire, England declare:
That the translator responsible for the attached translation is familiar with both the German and the English language, and that, to the best of RWS Group Ltd knowledge and belief, the attached English translation of International Application No. PCT/EP2005/002412 is a true, faithful and exact translation of the corresponding German language paper.

I further declare that all the statements made in this declaration of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful, false statements may jeopardize the validity of legal decisions of any nature based on them.

August 30, 2006

Date

Name: Charles Edward SITCH
Acting Managing Director
For and on behalf of RWS Group Ltd

Container and tool for fixing a connection piece

The invention relates to a container, in particular a header of a heat exchanger, with an orifice in which a connection piece is mounted. The invention also relates to a tool for fixing a connection piece in a container orifice.

In series manufacture, the installation of connection pieces in containers, such as headers of heat exchangers, takes place at separate workstations, not at the location where the containers are produced, since parts of the tools required for installing the connection pieces have to be introduced into the inner space of the container.

The object of the invention is to simplify the installation of a connection piece in a container orifice.

In a container, in particular a header of a heat exchanger, with an orifice in which a connection piece can be mounted or is mounted, the object is achieved in that the connection piece has, at its end facing the container, a deformable connection piece edge region which, before deformation, projects into the container and, after deformation, bears at least partially against the container orifice on the inside. According to one aspect of the present invention, it is not the complete connection piece edge region which is bent round or deformed, but only at least one portion of the connection piece edge region. According to another aspect of the present invention, however, the complete connection piece edge region may also be bent round or deformed.

A preferred exemplary embodiment of the container is characterized in that the deformable connection piece

edge region is connected with a form fit to the container orifice. The form fit is achieved preferably in that at least one portion of the connection piece edge region is deformed together with the associated portion of the container material having the container orifice. As a result of the form fit, the connection piece is fixed in the container orifice captively and securely in terms of rotation. The fixed connection piece may be connected to the container in a material integral manner in a subsequent soldering operation. The deformation of the connection piece edge region takes place preferably in the axial and radial direction with respect to the container orifice. However, the deformation may also take place only in the axial or in the radial direction.

A further preferred exemplary embodiment of the container is characterized in that the deformable connection piece edge region has a projection which, before deformation, projects radially inward and which, during deformation, is deformed radially outward. This exemplary embodiment affords the advantage that the deformation of the connection piece edge region can be brought about with the aid of a simple tool, for example a mandrel.

A further preferred exemplary embodiment of the container is characterized in that the projection is delimited by a continuous slope. The continuous slope forms an engagement surface for a tool for deforming the connection piece edge region. After deformation, the slope is preferably arranged in the direction of the connection piece longitudinal axis.

A further preferred exemplary embodiment of the container is characterized in that the continuous slope runs at an angle of about 45 degrees with respect to the connection piece longitudinal axis. This angle has

proved to be particularly advantageous within the scope of the present invention.

A further preferred exemplary embodiment of the container is characterized in that, in the edge region of the container orifice, at least one deformed region is formed, into which a complementarily deformed region of the deformable connection piece edge region engages. The type of deformation depends on the tool used. The deformed region preferably has the configuration of a spherical segment.

A further preferred exemplary embodiment of the container is characterized in that a collar is formed at that end of the connection piece which has the deformable connection piece edge region. The collar separates the deformable connection piece edge region from the rest of the connection piece. The collar forms an abutment when the connection piece is introduced into the container orifice. During the deformation of the connection piece edge region, the edge region of the container orifice is clamped between the collar and the deformable connection piece edge region, in order to fix the connection piece to or in the container orifice.

A further preferred exemplary embodiment of the container is characterized in that a continuous depression is formed radially on the outside between the collar and the deformable connection piece edge region. The depression forms a reception space for burrs which may be produced at the container orifice as a consequence of manufacture.

In the case of a tool for fixing an above-described connection piece in a container orifice, the object specified above is achieved in that the tool has at least one deformation element which can be moved out of

an introduction position into a deformation end position. In the introduction position, the deformation element is arranged in or on the tool such that the tool can be introduced from outside through the connection piece into the inner space of the container. When the deformation element is moved out of the introduction position into the deformation end position, the deformation element comes to bear against a portion of the connection piece edge region and deforms this portion until the latter comes to bear against the edge region of the container orifice. During the further movement of the deformation element into the deformation end position, that portion of the connection piece edge region against which the deformation element bears is deformed, together with the edge region of the container orifice, in order to bring about the form fit. The tool is preferably equipped with at least two deformation elements.

A preferred exemplary embodiment of the tool is characterized in that the deformation element is guided in the tool. Guidance ensures that the deformation element moves in a reproducible manner along a defined path of movement between the introduction position and the deformation end position.

A further preferred exemplary embodiment of the tool is characterized in that the guide path of the deformation element runs essentially transversely with respect to the connection piece longitudinal axis. The state when the tool is introduced through the connection piece into the container inner space is considered. The guide path of the deformation element may run perpendicularly with respect to the connection piece longitudinal axis. The guide path of the deformation element then runs parallel with respect to the plane which is defined by the container orifice. It is also possible, however, that the guide path of the deformation element runs

obliquely with respect to the plane which is defined by the container orifice.

A further preferred exemplary embodiment of the tool is characterized in that the guide path of the deformation element runs from the inner space of the container obliquely outward. The state when the tool is introduced through the connection piece into the container inner space is considered again. The oblique run of the guide path has the advantage that the deformation element moves out of the deformation end position into the introduction position more simply when the tool is extracted after the deformation of the connection piece edge region. This makes it easier for the tool to be extracted after the deformation of the connection piece edge region. When the tool is extracted, the deformation element is preferably located in the introduction position again.

A further preferred exemplary embodiment of the tool is characterized in that the deformation element cooperates with a ramp which can be moved in relation to the tool in the direction of the connection piece longitudinal axis. The state when the tool is introduced through the connection piece into the container inner space is considered. As a result of a movement of the ramp, the deformation element is moved out of the introduction position into the deformation end position.

A further preferred exemplary embodiment of the tool is characterized in that the ramp is formed on a frustoconical region which tapers outward. A plurality of deformation elements may bear against the frustoconical region and, in the event of a movement of the frustoconical region, move synchronously along their guide paths out of the respective introduction position into the deformation end position.

A further preferred exemplary embodiment of the tool is characterized in that the frustoconical region can be actuated from outside. The actuation may take place, for example, hydraulically or pneumatically.

A further preferred exemplary embodiment of the tool is characterized in that a connecting element, which is also designated as an actuating element, extends outward from the frustoconical region. The state when the tool is introduced through the connection piece into the container inner space is considered. The actuating element may be, for example, a threaded spindle. The connecting element may also be designated as a tie rod by means of which the frustoconical region is moved outward from the container inner space.

A further preferred exemplary embodiment of the tool is characterized in that the deformation element has an essentially convex region toward the container orifice. The state when the tool is introduced through the connection piece into the container inner space is considered. The convex region ensures a nondestructive deformation of the connection piece edge region in the radial and/or axial direction.

A further preferred exemplary embodiment of the tool is characterized in that the convex region comes to bear with its outwardly facing half against the deformable connection piece edge region. The state when the tool is introduced through the connection piece into the container inner space is considered. By means of the convex region of the deformation element, the connection piece edge region inside the container is deformed toward the edge of the container orifice.

A further preferred exemplary embodiment of the tool is characterized in that the deformation element is formed

by a sphere. The sphere is preferably guided in a bore which extends from outside into the frustoconical region.

A further preferred exemplary embodiment of the tool is characterized in that the tool has a plurality of deformation elements which are distributed, uniformly spaced apart, over the circumference of the tool. The tool is preferably equipped with six deformation elements.

Further advantages, features and particulars of the invention may be gathered from the following description in which various exemplary embodiments are described in detail with reference to the drawing. In this case, the features mentioned in the claims and in the description may be essential to the invention in each case individually in themselves or in any desired combination. In the drawing:

figure 1 shows a longitudinal section through a container with an inserted connection piece and with a tool arranged therein;

figure 2 shows a longitudinal section through part of the tool from figure 1;

figure 3 shows a top view of a connection piece inserted into a container orifice;

figure 4 shows a longitudinal section through a connection piece according to a further exemplary embodiment;

figure 5 shows an enlarged detail V from figure 4, and

figure 6 shows the detail from figure 5 after deformation.

Figure 1 illustrates part of a container 1 in section. A circular orifice 2 is cut out in the container 1. The container 1 is the header of a heat exchanger. A connection piece 5, which serves, for example, for connecting a coolant line, is inserted into the orifice 2 of the container 1.

The connection piece 5 comprises a basic body 6 essentially in the form of an envelope of a circular cylinder, with a connection piece longitudinal axis 8. A collar 7, which projects radially outward, is formed at that end of the basic body 6 which faces the container 1. On that side of the collar 7 which faces away from the basic body 6, the connection piece has a connection piece edge region 10 essentially in the form of an envelope of a circular cylinder. The connection piece edge region 10 projects into the inner space of the container 1, said inner space being designated in figure 1 by 12.

In figure 1, the connection piece 5 is inserted with the connection piece edge region 10 into the container orifice 2. The collar 7 is in bearing contact against the circumferential edge of the container 1, said circumferential edge delimiting the container orifice 2. A tool 15 is introduced through the connection piece 5 partially into the inner space 12 of the container 1, in order to fix the connection piece 5 in the container orifice 2. The connection piece 5 is fixed in the container orifice 2 in order to prevent a loosening of the connection piece 5 or a rotation of the connection piece 5 in the container orifice 2 before the connection piece 5 is connected to the container 1 in a materially integral manner by means of a subsequent soldering operation.

The tool 15 has, at its end projecting into the inner space 12 of the container 1, a tool head 16 which comprises a portion 17 tapering frustoconically outward. An extension 18, in which guide bores 21 and 22 are cut out, extends radially outward from the frustoconical portion 17. The guide bores 21, 22 run in the radial direction with respect to the connection piece longitudinal axis 8. A sphere 25, 26 is received in each of the guide bores 21, 22 so as to be movable back and forth.

The tool head 16 having the frustoconical portion 17 can be moved in relation to the extension 18 in the direction of the connection piece longitudinal axis 8. For this purpose, the tool head 16 has fastened to it a spindle 30 which extends outward from the tool head. An actuating element 32 is screwed to the free end of the spindle 30 which has an external thread. When the actuating element 32 is rotated in the appropriate direction, the tool head 16 having the frustoconical portion 17 is then pressed against the spheres 25 and 26. The spheres 25 and 26 are thereby moved radially outward in their guide bores 21 and 22 in order to deform the connection piece edge region 12. In this case, the dimensions of the frustoconical portion 17, of the guide bores 21 and 22 and of the spheres 25, 26 are selected such that those halves of the spheres 25, 26 which face the actuating element 32 bear against the connection piece edge region 10. What is achieved thereby is that those portions of the connection piece edge region 10 against which the spheres 25, 26 bear and the connection piece edge region 10 are bent round toward the circumferential edge of the container orifice 2 when the spheres 25, 26 are moved radially outward in their guide bores 21, 22.

When the tool head 16 is moved somewhat further into the inner space 12 of the container 1 in figure 1, the

spheres 25, 26 can move radially inward until they have reached their introduction position. In this introduction position, the spheres 25, 26 are received completely in the guide bores 21, 22, so that no part of the spheres 25, 26 projects radially from the guide bores 21, 22 on the outside. In this state, the tool 15 can be introduced through the connection piece into the container inner space 12 and be led out of the container inner space 12.

In figure 2, the extension 18, which may also be designated as a tool head guide element, is illustrated alone in longitudinal section. A recess 40 is cut out at one end of the tool head guide element 18. The recess 40 is formed complementarily to the frustoconical portion (17 in figure 1). Two guide bores 41, 42 extend outward from the recess 40. However, the guide bores 41, 42 do not, as in figure 1, run perpendicularly with respect to the connection piece longitudinal axis 8 which corresponds to the longitudinal axis of the tool 15, but are inclined obliquely with respect to the connection piece longitudinal axis 8. Moreover, a central through bore 44 for receiving the spindle (30 in figure 1) is provided in the tool head guide element 18.

Figure 3 illustrates a top view of a connection piece 5 which is fixed in an orifice 2 of a container 1. Circles 51 to 56 indicate six spheres of a tool (otherwise not illustrated). The spheres 51 to 56 are in what is known as their introduction position. The deformation end position of the sphere 54 is indicated by dashes at 58. When the spheres 51 to 56 are moved out of their introduction positions into their deformation end positions, form-fit connections 61 to 66 are made between the connection piece edge region 10 and that edge of the container orifice 2 against which the connection piece edge region 10 of the connection

piece 5 bears. The form-fit regions 61 to 66 have the configuration of spherical segments, the inner radii of which correspond to the outer radii of the spheres 51 to 56.

The hardened spheres 51 to 56 are pressed outward in the tool along the guide bores by the frustoconical region of the tool head. The embossing of the connection piece edge region takes place below the maximum diameter of the spheres. The connection piece 5 is thereby drawn against the container in the axial direction. The spheres emboss the connection piece edge region outward and lead to a form-fit connection between the container and connection piece. The mounting of the connection piece may take place from only one side, to be precise from outside, for example by means of a simple hand tool.

Figures 4 to 6 illustrate an exemplary embodiment of the invention in which preferably the complete connection piece edge region is deformed. It is also possible, however, that the deformable connection piece edge region is deformed only partially. The exemplary embodiment illustrated in figures 4 to 6 has the advantage that a simple mandrel can be used in order to deform the deformable connection piece edge region.

Figure 4 illustrates a connection piece 85 which comprises a basic body 86 essentially in the form of an envelope of a circular cylinder, with a connection piece longitudinal axis 88. A collar 87 which projects radially outward is formed at one end of the basic body 86. Between the basic body 86 and the collar 87, the connection piece 85 has a region 89 widening conically toward the collar 87. On that side of the collar 87 which faces away from the basic body 86, the connection piece 85 has a connection piece edge region 90. In the installed state, the connection piece edge region 90

projects into the inner space of a container (not illustrated in figure 4).

The connection piece edge region 90 has a portion 92 essentially in the form of a sleeve or in the form of an envelope of a circular cylinder, which extends from the inner circumference of the collar 87 in the direction of the connection piece longitudinal axis 88. A continuous depression 94 is formed radially on the inside between the sleeve-shaped portion 92 and the collar 87. As seen in section, the connection piece edge region has at its free end a projection 96 which projects radially inward. Between the sleeve-shaped portion 92 and the projection 96, a continuous slope 98 is formed on the connection piece edge region 90. The continuous slope 98 runs at an angle 100 of 45 degrees with respect to the connection piece longitudinal axis 88. The projection 96 has radially outward an outer surface 99 which extends parallel with respect to the connection piece longitudinal axis 88. Figure 5 shows the connection piece edge region 90 as it appears before deformation.

Figure 6 illustrates the connection piece edge region 90 after deformation. In figure 6, a part of a container which has an orifice 105 is indicated by 104. As a consequence of production, burrs 106 are formed at the orifice 105 and, in the mounted state of the connection piece 85, is arranged in the depression 94. It can be seen in figure 6 that, as seen in section, after deformation, the slope 98 on the connection piece edge region 90 is arranged in a line with the inner surface of the sleeve-shaped portion 92. After deformation, the outer surface 99 of the projection 96 extends outward. What is achieved thereby is that the connection piece edge region 90 surrounds the orifice 105 of the container 104.